Univ. of Michigan
General Library. O#68688
Ann Arbor, Mich.

UNIVERSITY OF MICHIGAN
1959
CATION
RARY

The American Biology Teacher

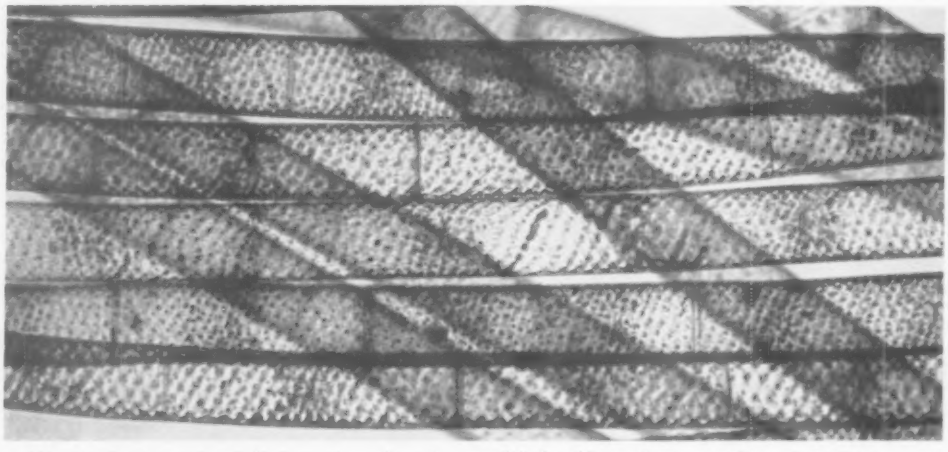
JANUARY, 1959 VOLUME 21, No. 1

Nucleic Acids and Heredity

Winter Field Experiences

Fishing for Nematodes

Turtox Nutrient Concentrates for Culturing Algae and Protozoans



Photomicrograph of living strands of a multiple-chloroplast species of Spirogyra.

These concentrates are easy to use; when added to the indicated amount of distilled water, each group of units makes approximately one liter of growing medium. The use of the "Universal" concentrate (below) enables any teacher to grow and maintain permanent pure-line cultures, including pure cultures of such difficult forms as Volvox and Pandorina.

61V170 Turtox "Universal" Concentrated Algae Medium. Especially formulated to grow Volvox, Eudorina, Pandorina, Chlamydomonas, Spirogyra, Zygnema, etc.

Set A: Consists of four units and **makes one liter** of growing medium in distilled water.
Set of four units (distilled water is not included)..... **$3.50**

Set B: Consists of four units and **makes five liters** of growing medium in distilled water.
Set of four units (distilled water is not included)..... **8.50**

61V176 Turtox Concentrate for Paramecium multimicronucleatum and P. caudatum. Makes 1500 cc. of growing medium in distilled water. Set of three units (distilled water is not included)..... **3.50**

61V177 Turtox Concentrate for Paramecium aurelia and P. trichium. Makes 1500 cc. of growing medium in distilled water. Set of three units (distilled water is not included)..... **3.50**

61V178 Concentrate for Paramecium bursaria. Each vial makes 300 cc. of growing medium in distilled water. Per vial (distilled water not included)..... **2.00**
Set of two vials (distilled water not included)..... **3.50**

61V179 Dehydrate for Euglena. Makes 2000 cc. of growing medium in distilled water. Set of two units (distilled water is not included)..... **2.00**

The three Turtox Constant-Temperature Laboratories maintain thousands of cultures of all of the generally studied protozoans, algae, ciliates, molds and bacteria. It is worth remembering that Turtox absolutely guarantees living arrival to any address in the United States. Cultures which die or deteriorate in transit are replaced immediately and without charge.

FOR THE BIOLOGICAL SCIENCES
TURTOX PRODUCTS

GENERAL BIOLOGICAL SUPPLY HOUSE
Incorporated
8200 South Hoyne Avenue, Chicago 20, Illinois

The Sign of the Turtox Pledges Absolute Satisfaction

TABLE OF CONTENTS

The Nucleic Acids and Heredity
British Scientists' Theories on Evolution 7
D. M. Brown

Books for Biologists 9, 11, 21, 23, 25, 27

Prairie Research in Iowa 9
J. M. Aikman

How Mission 66 Relates to Biology Teaching 11
Edwin C. Alberts

Outdoor Laboratory Series—No. 4
Winter Field Experiences for Biology Teachers 14
Robert A. Bullington

Laughing Doves in the Lab 17
W. F. Hollander

Fishing—for Nematodes 20
Mary Eileen Costa

An Inductive Approach to the Teaching of Science
Through Teacher—Pupil Planning 22
Herbert F. A. Smith

Teaching Environmental Responses 24
John Forsythe, Jr.

Diabetes 25

Cover Photograph

This picture shows the two, lobed leaf blades of the Venus's flytrap plant. Photograph by Professor S. N. Postlethwait, Department of Biological Sciences, Purdue University.

THE AMERICAN BIOLOGY TEACHER

Publication of the National Association of Biology Teachers.

Issued monthly during the school year from October to May. Second class postage paid at Danville, Illinois.

Publication Office—Interstate Press, 19 N. Jackson St., Danville, Ill.

Co-Editors—RICHARD ARMACOST, Department of Biological Sciences, Purdue University, West Lafayette, Ind.; PAUL KLINGE, Coordinator for School Science, Indiana University, Bloomington, Indiana.

The Purdue University address will be the official editorial office. Manuscripts and all publication material may be sent to either of the Co-Editors.

Managing Editor—MURIEL BEUSCHLEIN, 6431 S. Richmond, Chicago 29, Ill.

Subscriptions, renewals, and notices of change of address should be sent to the Secretary-Treasurer, PAUL WEBSTER, Bryan City Schools, Bryan, Ohio. Correspondence concerning advertising should be sent to the Managing Editor.

Annual membership, including subscription, $3.75, subscription to Journal, $3.75, individual copies, $.50, outside United States, $4.50, individual copies, $.50.

Specify DIFCO *. . . the only complete line of microbiological reagents and media*

Culture Media
Microbiological Assay Media
Tissue Culture and Virus Media
Serological and Diagnostic Reagents
Bacterial Antisera and Reagents
Sensitivity Disks Unidisks
Peptones Hydrolysates Amino Acids
Enzymes Enrichments Dyes Indicators
Carbohydrates Biochemicals

Over 60 years' experience in the preparation of Difco products assures
UNIFORMITY STABILITY
ECONOMY

Complete Stocks
Fast Service *24-hour Shipment*

Difco Manual and other descriptive literature available on request

DIFCO LABORATORIES
DETROIT 1, MICHIGAN

MEMBERSHIP APPLICATION

NATIONAL ASSOCIATION OF BIOLOGY TEACHERS

Name _____
(Please Print)

Address _____

_____

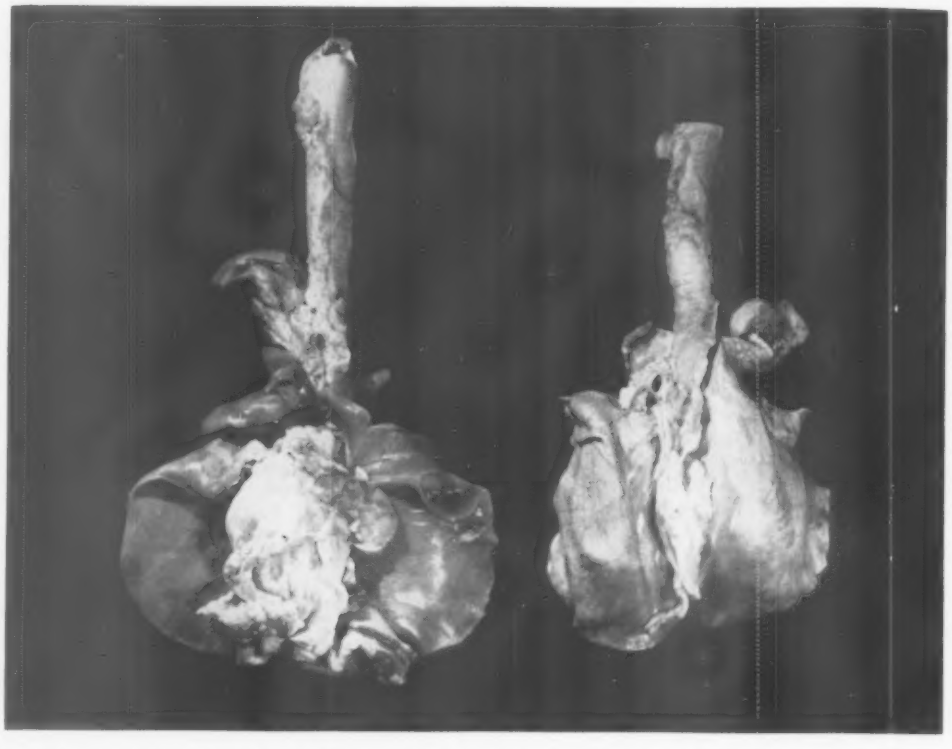
Dues: $3.75 a year, including subscription to

THE AMERICAN BIOLOGY TEACHER
For one year (8 issues)

Send application to:

Paul Webster, Secretary-Treasurer
Bryan City Schools, Bryan, Ohio

Better Preserved Material Is Now Available for Lung and Heart Studies



The lung and heart together which we call the light is excellently portrayed in material prepared from young lambs. The lungs are well embalmed and the entire specimen is well preserved in formalin.

Each, in less than dozen lots	$ 1.50
Per dozen	$ 15.00
Fifty	$ 60.00
Hundred	$119.00

You may want the lungs and trachea separate from the heart. In that case you can order them separately or you can order lungs or hearts whichever you desire.

The Plain Sheep Heart

Individually packaged in a round quart glass jar.
50¢ each, $5.00 per dozen, Fifty for $20.00, $39.00 per hundred.

Bulk packaged in wide mouth gallon jars.
40¢ each, $4.00 per dozen, Fifty for $16.00, $31.00 per hundred.

The Lungs and Trachea of the Sheep

The lungs are embalmed and well preserved. Each in less than dozen lots 50¢, $5.00 per dozen, Fifty for $20.00, $39.00 per hundred.

Any of the above described specimen materials can be had in a fresh frozen condition delivered to you fresh anywhere in the Continental United States. Specimen materials that are fresh cost 25% more than preserved specimens.

Containers and shipping charges are extra and will be added to your invoice.

ALL MATERIAL CARRIES A 100% GUARANTEE.

BIOLOGICAL RESEARCH PRODUCTS CO.
243 West Root Street, Stockyards Station
Chicago 9, Ill.

The Nucleic Acids and Heredity

British Scientists' Theories on Evolution

DR. D. M. BROWN

Assistant Director of Research in Chemistry
at the University of Cambridge, England

There is one problem which has occupied a central position in the thoughts of biologists for many years. It is that of the continuity of life's patterns. How is it that the parents can be seen again in their children, and this through generation after generation? The sculpture of ancient Greece is still seen in the forms of men and women today.

When a bacterial cell divides, the daughter cells are identical to it and to each other. When a bacteriophage attacks a bacterium, the bacterium will die but perhaps a hundred bacteriophage appear, each identical to the first. But at the same time, very slowly, living species change, evolve. How is the amazing constancy maintained and how does the very slow evolution, superimposed upon it, come about?

Very Difficult Chemistry

With the remarkable growth during this century in our understanding of the chemistry of living things it has become evident that these twin problems, heredity and evolution, must have explanations in terms of chemistry—at the molecular level. Very difficult chemistry it may be, but it is still chemistry.

When a cell divides giving rise to two daughter cells, remarkable changes occur within it, particularly within the cell nucleus. Here threadlike objects, the chromosomes, arrange themselves in a particular way; at one stage they double, then separate into two sets, and, when the whole cell divides, one set goes into each new cell.

The science of genetics is firmly based on the well established view that the chromosomes carry the new cell's inheritance. Chromosomes seem to be composed of two things, protein and deoxyribonucleic acid (DNA). Much discussion and research has gone into the question of which is the genetic carrier.

During the last few years, a feeling of certainty has grown that the responsible molecules are the nucleic acids. One reason is that in a living cell, while most of the constituent molecules are being broken down and reformed (metabolised), the DNA is an exception. It does not take part in the general metabolism; in this sense it is inert, the amount of it only increasing just before the cell divides. This is the kind of constancy we should wish for a genetic substance.

As another reason we could cite the bacteriophages. They contain protein and nucleic acid. But the protein for the most part seems only to form the envelope enclosing the nucleic acid. When a cell is attacked by a 'phage only its nucleic acid enters.

New Knowledge on Structure

But the realization of the potentialities of DNA would have been less sure had it not been for the new knowledge on the structure of these complicated molecules, much of which came from the research work of chemists and physicists in London and Cambridge. One kind of nucleic acid, the nuclear deoxyribonucleic acid, has been mentioned.

Another kind, ribonucleic acid (RNA), is found in the nucleus and the cytoplasm of the cell. Both types consist of very long threadlike molecules.

Work in many countries has shown the basic components which, linked together, make up the nucleic acids. These are phosphoric acid, several nitrogen-containing substances known as purine and pyrimidine bases, and a sugar, ribose (in RNA) and deoxyribose (in DNA). Each of the components is complicated in itself so that the important problem of finding how they are joined together was a very difficult one indeed.

We now know that a general structure for

the nucleic acid molecules can be written in the form:

```
B       B       B       B
|       |       |       |
S – P – S – P – S – P – S – P.....
```

where B, S and P represent the base, sugar and phosphate.

Chemical Research

Much of the recent research which brought the earlier work to fruition was carried out by Professor Sir Alexander Todd and his colleagues. They showed, mainly by synthetic chemical methods, how the bases are linked to the sugar to give the nucleosides (B–S) and then how the phosphate is linked to the nucleosides forming the nucleotides (B–S–P).

From a study of the nucleotides, a much clearer understanding of their chemistry emerged and this in turn showed the precise way in which these units are linked together in the nucleic acids themselves. It seems quite certain now that both RNA and DNA are long molecules which have no branches. They consist of a sugar phosphate (–S–P–) backbone to which are linked the bases, of which there are four principal ones. A nucleic acid from any given source can be analyzed to find the proportions of each base present.

In the case of DNA, which contains the purine bases adenine (A) and guanine (G) and the pyrimidines thymine (T) and cytosine (C), the remarkable observation was made that the amount of adenine was always the same as the amount of thymine and the same held for guanine and cytosine; but the ratio of, for example, adenine to guanine was quite far from one. The contribution of the physicists to the structure of DNA gave a surprising and revealing explanation for these base proportions.

Molecular Flexibility

Molecules are flexible and, particularly in large molecules, the constituent atoms or groups of atoms can take up many different orientations—as we now say, the molecule can have many possible conformations (in German, the expressive "constellation"). But some are more favored than others. This was the case with DNA. When looked at in the electron microscope, they appeared as very narrow and rather rigid rods. Much more detail could be seen when they were studied by the methods of X-ray crystallography.

These experiments and their interpretation carried out by Dr. Crick and Dr. Watson and by the late Dr. Rosalyn Franklin and her colleagues showed that the rods were actually composed of two nucleic acid chains wound round each other in a helical fashion. As an analogy we might think of two long springs screwed into each other.

Moreover, the sugar-phosphate backbones formed the outside of the double helix. The bases lay inside, pointing towards each other, each base on one chain being held weakly to a corresponding base on the other chain. A model showing a small part of a DNA molecule, which reveals clearly the very beautiful complex structure, is now on show at the Universal and International Exhibition in Brussels.

Bold Suggestion

Remembering the peculiar base ratios found by the chemists, Watson and Crick made the bold suggestion, still to be proved, that an adenine on one chain could only be "paired" with a thymine on the other, and similarly a cytosine only with a guanine. The two chains in the double helix would then be complementary—in the same way as a key is complementary to its lock. The importance of this is that it allows, for the first time, a hypothesis to be made as to how DNA can carry out its biological functions.

It must, first of all, be capable of duplication. The double helix, made of complementary chains, could fulfill the requirement. If the two strands became separated, each, because of its complementarity, could be the basis for the formation of another nucleic acid double helix, identical to the first. Thus two nucleic acid chains or two sets of chromosomes would be available when the cell divided. In this way the cell's inheritance would be maintained.

Possible Chemical Basis for Evolution

Suppose that the nucleic acid of a cell is slightly altered in some way, for example by cosmic or other radiation, if the alteration were retained, the subsequent generations of cells would show this alteration in one way or another. An accumulation of such alterations might form the chemical basis for evolution.

We are becoming familiar nowadays with automatic machines, machines which carry out complicated processes controlled, not by

men, but by information which is fed to them on magnetized or perforated tape. Soon, whole factories may operate this way. The living cell in all its complexity is really just a chemical factory. The controller resides in the chromosomes and is, we now think, the nucleic acid.

How is the information stored in the nucleic acid? The present idea is that, in some way, the sequence of the bases along the chain represents a code. There are, of course, very many ways of arranging the four bases, just as, for instance, there are many possible arrangements of differently colored beads on a necklace.

Rapidly Developing Field of Research

How does the cell translate the information given to it by the nucleic acid? The individual chemical reactions in the cell are controlled by enzymes which are protein, each differing from the other in the sequence of their building blocks, the amino acids. Some biochemists think that each DNA molecule acts as a template for the formation of an RNA molecule and then this acts as a template for the formation of a specific protein, an enzyme. Thus the base sequence in the DNA could decide the base sequence in the RNA and this, in turn, could ensure the correct amino-acid sequence in the enzyme.

Ideas in a rapidly developing field of research are always changing and the present ones may seem naive and out of date in a year or two; they may even be quite wrong. But they are stimulating a lot of research work and this is all that can be expected of scientific hypotheses.

Nevertheless, it is legitimate to feel that just as the first half of the 20th century brought an enormous increase in our understanding of the atomic nucleus, so the second half may do the same for the nucleus of the living cell.

BOOK

DISSECTION GUIDES: H. G. Q. Rowett, $0.95 each, Rinehart and Co., Inc., New York, New York, 1957.

I.	The Frog	63 pp.
II.	The Dogfish	62 pp.
III.	The Rat	64 pp.
IV.	The Rabbit	32 pp.
V.	Invertebrates	56 pp.

This series of drawings is designed to aid dissection visually with the minimum of written instruction. No attempt is made to describe the form or relations of the parts.

Prairie Research in Iowa*

J. M. AIKMAN
Iowa State College

Settlers from central Indiana, moving westward at the beginning of the 19th century, soon found themselves horseback-deep in a luxurious, herbaceous plant community, the prairie. Beginning with some sizeable areas near Lafayette, the prairie alternated with forests across Illinois and eastern Iowa. On the upland across most of Iowa and into Nebraska the prairie continued, becoming gradually less luxuriant. In central Nebraska it was replaced by the mixed prairie which in turn gave way to the short grass plains bordering the eastern foothills of the Rocky Mountains. Settlers who followed this route crossed the prairie and the entire central grassland formation at its widest extent.

In this paper prairie research in Iowa has been divided into two periods: (1) The pioneer period and (2) The last thirty years.

The pioneer period began about 1800 with a number of studies which were chiefly survey reports. A comprehensive review of these was included in Shimek's 1911 paper, "The Prairies," in which is reported the results of the first fundamental research on the prairie in Iowa. Schaffner, 1913, 1926, described the structure of the prairie as well as other grassland associations and discussed the effects of factors but presented no factor data. Pammel and Hayden made important contributions during this period.

The last thirty year period has been characterized by the diversity of approaches which have been made in prairie research. Transeau's paper on the prairie peninsula in 1935 attracted attention to the Iowa prairie which occupies the important central position of the "peninsula." His thesis that the prairie was the product of all the factors of its habitat rather than of one or two, as fire and soil structure, agrees with the earlier concepts of Shimek, Schaffner, Hayden and others and with the later research results of

*Presented to the American Nature Study Society at its meetings with the American Association for The Advancement of Science, Indianapolis, December, 1957.

several workers, including our own group, but is at variance with the opinions held by many early and modern "students" of the prairie. Weaver and his students at Nebraska have included a few Iowa plots in their studies and have applied some of their findings to Iowa conditions.

Contributions to prairie research in Iowa in this latter period have been made by the following and others: H. S. Conard, Ada Hayden, G. O. Hendrickson, W. E. Loomis and A. L. McComb, F. F. Riecken and by R. F. Thorne. The following of our own students have made contributions to one phase or other of the prairie research problem in Iowa: Ivan Boyd, H. E. Brewer, William Dickpeddie, J. H. Ehrenreich, C. L. Kucera, Frank Kulfinski, A. F. Larason, R. E. McDermott, R. L. McDill, J. F. Moyer, M. L. Shubert, H. S. Ward and R. M. Warner.

By investigating virgin prairie tracts in various parts of Iowa, and by other approaches to the problem, it has been possible to reconstruct the vegetation of the state and present various quantitative data of the Iowa prairie as well as some concepts which help us to picture the role of the prairie in shaping the present economic and cultural patterns of the state.

A typical prairie tract of 160 acres was composed of about 200 species of higher plants. For the entire state the number would be in excess of 350 because of the differences in habitat requirements. The ratio of the number of species of grasses and sedges to the number of herbaceous nongrasses (forbs) was about 1:3. The prairie can be differentiated into the upland prairie (sometimes called the true prairie) and the lowland prairie occupying less well-drained and less well-aerated areas. The upland prairie was the vegetation responsible for the development of Clarion, Carrington, Marshall and similar soils and the lowland prairie was that responsible for the development of Webster, Floyd and similar soils and of several alluvial soils.

The grasses were the plants in control in the prairie community, the dominants, chiefly because of their duration of growth throughout the growing season. The forbs, mostly with showy flowers, were more seasonal in their development, formed seasonal societies in the prairie and had less effect on the structure of the vegetation pattern of the prairie. Characteristic societies are shown in color.

Iowa prairie was more luxuriant in growth than the strip of prairie to the west. The ratio of average yield of prairie from the western border of the prairie in Nebraska to midwestern Iowa to northeastern Iowa is inversely related to the precipitation: evaporation ratio but shows a close relationship. These yields in tons per acre, from west to east for the upland prairie are 1.7: 2.2: 2.6. Yields of lowland prairie are often 50 per cent higher but show less regional difference because local soil moisture supply has more effect on yield than does the vapor pressure deficit of the atmosphere.

The rate of soil development depends chiefly on the rate of addition of total organic matter to the soil. Within both upland and lowland prairie, those prairie stands which have high annual hay yield also have a high yield of roots and underground stems. The rate of soil development consequently increases from west to east across Iowa.

The rate of improvement in soil structure in the prairie is greater in Iowa prairie than westward and increases from west to east across the state. This is indicated by values, from west to east, of lower soil volume weight, higher aeration porosity, and higher percentage of soil aggregates. In the formation of soil aggregates there are plant species differences which sometimes are independent of the quantity of organic matter.

State-owned tracts of virgin prairie in Iowa have been managed satisfactorily by initiating complete protection till they recovered from excessive mowing for hay and then mowing about two-thirds of the tract every year under close observation. Experiments have shown that the burning of Iowa prairie, which had two and one half tons per acre of litter and duff, increased the number of seed stalks of dominant grasses 5 to 8 times and their height about 25 per cent. Canada wild rye in the lowland prairie was an exception, showing no effect. By the third growing season the number and height of the seed stalks were about the same as on the unburned area. If the burned areas were mowed this reversion to the original condition was not so rapid. In contract to the effect on native grasses, burning decreased the frequence and abundance of seeds, stalks of Kentucky bluegrass, redtops, timothy and other invading grasses.

Large acreages of virgin prairie in Iowa

have been converted to bluegrass simply by grazing. Invasion of bluegrass under the mesic conditions favorable for its growth seems to be much more difficult to control in Iowa than in prairie farther westward where conditions become progressively less favorable for the growth of bluegrass. Bordering most of the streams in Iowa, tree and shrub communities have invaded soils which exhibit the typical prairie profile. The chief reason for this invasion was destruction of the prairie along these borders by uncontrolled grazing.

Before the advent of the white man, prairie covered approximately 84 per cent of the area of Iowa. The causes of its origin and development are many rather than few. The prairie was the product of its total environment. For the greater part of Iowa the climate was more favorable to the water balance of the grasses and forbs of the prairie than of trees of the deciduous forest. Furthermore, there seems to be little evidence that changes of sufficient magnitude in climatic or soil factors have occurred in 150 years to cause a permanent change in the vegetation. Modifications in the vegetation of local areas are probably attributable to the destruction of the prairie rather than to changes in environment.

Experimental planting of prairie in many parts of Iowa have been successful; on cropland, in permanent bluegrass pastures, on eroded areas and on graded highway backslopes of 50 percent slope. On cropland of moderate fertility, yields have approached or surpassed those of virgin prairie in the vicinity. Under natural conditions no vegetation has matched the prairie in the development of soils. The prospect of improving the structure of the soils of long-term landbank areas in Iowa by planting of prairie would seem to be excellent.

BOOK

Isotopic Tracers, G. E. Francis, W. Mulligan and A. Wormall, 306 pp, $7.00, The Athlone Press, London, England, 1954.

The first part of this book offers a concise but adequate treatment of the theoretical principles underlying the preparation and measurement of radioactive and stable isotopes, and their use as biological tracers, together with practical information about instrumentation, techniques, etc. The second part contains detailed instructions for a course of practical exercises.

How Mission 66 Relates to Biology Teaching

EDWIN C. ALBERTS

Regional Naturalist, National Park Service, Omaha, Nebraska

When Congress set apart our first national park, Yellowstone, in 1872 as a "public park or pleasuring ground for the benefit and enjoyment of the people . . .," little did it realize or perhaps give much concern to the fact that, nearly a century later, over 60 million people would annually visit our parks, national monuments, and historic sites.

Today there are 27 national parks, over 150 monuments, and a host of historic areas, scattered from coast to coast and border to border, all administered for the public welfare by the National Park Service of the Department of the Interior.

The Congress of 1872 undoubtedly didn't foresee that some day a program would be necessary to protect the irreplaceable features

of our national parks and to take care of the increasing millions of visitors. But, nearly 85 years later, Park Service officials found such a program was not only necessary, it was of the utmost urgency, if the National Park System was to be brought up to the standards the American people want and have a right to expect. Therefore, in 1955, a forward-looking plan—MISSION 66—was proposed. This is a 10-year program which began in 1955 and should be completed in 1966, the 50th anniversary of the establishment of the National Park Service.

How do the MISSION 66 programs relate to your profession? Perhaps the program that is most closely tied in with biology teaching is what we in the National Park Service call the "interpretive program." Actually the interpretive program in the parks has been in operation since the early 1920's—long before MISSION 66. Today it is designed to carry out one of the objectives of MISSION 66, which is "to provide the services which will make the parks more usable, more enjoyable, and more meaningful, and thereby improve the protection of the park through visitor cooperation."

If you, the biology teacher, come to a park as a visitor, you will probably take one or maybe several of the free ranger-naturalist guided walks and hikes which are a part of the park's interpretive program. On these well-planned field trips you will be introduced to the complex story of the area's natural history. You will see that although geology or human history may loom high in some areas, biology is never completely out of the picture. In areas like Everglades and parts of Yellowstone, biology becomes the predominant theme.

Or you may come to a park as a temporary summer naturalist. To make sure the facts and theories we present in our interpretive program are currently accepted and are of professional quality, many of our summer naturalists are recruited from the campuses of universities, colleges, and high schools. A large number of them are biology teachers during school months. Although the pay is meager and living conditions often very primitive, these teacher-naturalists are the backbone of our summer interpretive program, and many return to the parks summer after summer.

But it seems to make little difference whether the person comes as a visitor or as a summer naturalist. In either case, without fail, he develops an overwhelming enthusiasm to learn more about the natural features of the area where he happens to be.

We've seen many examples where a budding biologist has his interest aroused in the subject by one or more successful field trips through a park. Sometimes the young visitor decides to be a biologist after he discovers how fascinating the subject is in a National Park. Some of our permanent park naturalists—today's younger ones at least—attribute their interest in the subject to a park visit. More than one successful biology teacher has told me the same story.

Many a fundamental biological concept has been "discovered" by adult laymen who have had contact with the interpretive program of a national park. As a biology teacher, this may be of only marginal interest to you but such experience may help your work in obscure ways. Certainly parents who have absorbed material covered in our natural history exhibits are unlikely to make a fuss about their small children being taught that the earth is very old. They are likely to realize that such things as evolution and natural selection are not subversive, un-American concepts. Park interpretive programs are directly related to sound philosophies of resource conservation, and they unquestionably contribute to understanding the complex interdependence of living things.

To carry out an intelligent and a large-scale interpretive program, our parks must be well equipped and staffed. In 1955 we found the areas were only able to handle about half of the people who visited them. In 1940 we had about 25 million park visitors; in 1955 we had over 50 million; by 1966 at least 80 million will visit our areas. Physical plant facilities—roads, trails, lodgings, campgrounds, etc.—were, in most cases, completely inadequate, out-of-date, and run down. Since World War II put an end to the CCC program, until recently there has been little opportunity to improve Park Service areas because of wartime and defense emergency obligations of the Federal treasury. Acceptance of this program by the Administration and the Congress is a gratifying response to the will of the people.

Although MISSION 66 is a big program, it is one a nation prosperous as ours can well afford. Estimated costs of the program have varied. To carry out the program of rebuild-

ing and meeting visitor requirements, the National Park Service has estimated it will cost about 800 million dollars during the 10-year period. Of this, over 475 million will be required for construction and rehabilitation of roads, buildings, utilities, and other facilities. This is a large sum, to be sure, but in comparison with the rest of the Federal budget, it is a relatively small amount when prorated over a 10-year period, and when you consider that untold millions of our citizens will directly benefit from such an investment.

Our programs of nature study—interpretation of the natural scene—will profit from this program in several ways. Perhaps the benefit that will be most obvious to you when you visit the parks are the number of new Visitor Centers—we used to call them "museums"—being built. Not only will these structures serve as information centers for visitors, but nearly all of them will contain museum exhibits explaining the natural and human history of each area. Many such displays regarding a park's flora, its birds and mammals, or general ecological situations, have biological themes and are often cleverly portrayed. Some of these exhibits have been copied and used for classroom purposes. Biology teachers are therefore usually quite interested in our museums and their interest will undoubtedly increase as new Visitor Center exhibits are planned and built.

The MISSION 66 program calls for an increase in the personnel available for interpretive work; many more seasonal and a few more permanent naturalists will be employed as funds are appropriated. These new persons will, in turn, provide more personal service to visitor groups and will vastly increase the dissemination of biological understandings to the lay public. In many cases, biology teachers, wishing to enrich their teaching experience by field work with adult and family groups, will fill these new seasonal positions.

We realize a number of areas cannot possibly provide personally conducted information tours. In these places, we are placing con-

siderable reliance upon roadside interpretive signs and self-guiding nature trails. MISSION 66 will provide a great number of new signs and trails. Badlands, Death Valley, and Wind Cave are examples of areas where the visitor will depend heavily upon roadside markers for his nature study. A number of these exhibits are being planned for the larger areas, for example, several new roadside exhibits are being erected in Yellowstone. Look for them on your next summer trip.

At first glance, this development program for the National Park Service has limited significance to biology teaching. But if you examine it as part of our National Park Service interpretive program, you find numerous features applying to the profession. So MISSION 66 should be of more than passing interest to you, not only as citizens of the republic and potential park visitors, but as people dedicated to education in science.

Outdoor Laboratory Series — No. 4

Winter Field Experiences for Biology Teachers

ROBERT A. BULLINGTON
Northern Illinois University, DeKalb, Illinois

A course entitled "Methods and Materials for Teaching High School Biology" is offered each semester for majors in biology at Northern Illinois University. One unit of this course covers field trip techniques.

In December, 1957, a new procedure for teaching about field trips was tried. This consisted of taking the class for a three-day visit to the branch campus of the University, the Lorado Taft Field Campus, at Oregon, Illinois.

This branch campus is a 65-acre heavily wooded area of hills, ravines, and bluffs on the bank of the Rock River north of the town of Oregon. It is adjacent to Lowden Memorial Park, a part of the park system of Illinois.

The field campus is equipped for year-round use and is devoted to the outdoor education phase of the teacher-training program of Northern Illinois University.

Classroom Preparation

Preliminary plans and a tentative schedule of activities were carefully worked out in the classroom. This pre-planning was an important part of the learning experiences of the students.

Two assignments were given to the class. Each student was asked to examine a textbook for high school biology and to make a list of the subject-matter items that could be taught in the out-of-doors in the winter. The lists were reviewed in class and a master list of winter activities was prepared. The list follows:

Winter Field Activities in Biology

I. Animal Study
   - A. Birds:
     Identification, banding, food habits, behavior, old nests
   - B. Mammals:
     Winter homes, food, behavior, tracks, identification
   - C. Insects:
     Winter survival, galls, damage to plants
   - D. Special adaptations for winter survival
   - E. Students:
     Individual physiological reactions to outdoor activity in cold weather

II. Plant Study
   - A. Trees and Shrubs
     1. Identification in winter condition by bark, branching, twigs, leaf scars, buds
     2. Age of trees, measurement
     3. Grafting
   - B. Fruits and seeds
   - C. Roots
   - D. Mosses
   - E. Algae
   - F. Fungi
   - G. Relation of plants to environment
     1. Hilltop and flood plain
     2. Slopes, steepness, exposure
     3. Prairie openings
     4. Effect of crowding

The characteristics of a black oak are discussed by the student leader

The instructor points out tree-ring patterns on the 150-year old branch of a bur oak

5. Effect of substratum
6. Plant succession
7. Examples of formations or biomes

III. Miscellaneous
- A. Aquatic life
- B. Conservation
  1. Plant and animal resources
  2. Effect of man's activities
  3. Erosion
- C. Soils:
  Structure, types, profile
- D. Fossils
- E. Winter weather and the unfavorable winter environment

For a second preliminary assignment, the students were asked to find and read an article about teaching biology in the out-of-doors. Each was discussed in class. A bibliography of all the articles was prepared and distributed.

The students gained experience in field trip planning by assisting the instructor in organizing the details of the three-day experience.

Field Experience

At the field campus, the group was able to concentrate upon field experiences for the camp has a regular staff of cooks and maintenance men who take care of the routine work of camp life.

A brief outline of the learning activities follows:

Monday morning: Trip to camp, getting settled, orientation to camp life.

Monday afternoon: Discussion of the philosophy of outdoor education, followed by a field trip to show the natural resources of of the area and to demonstrate various field techniques, especially the use of the senses.

Monday evening: Evaluation of the afternoon trip, discussion of pre-planning for field trips, and planning for the next day. Recreation period.

Tuesday morning: Field trip in forest to demonstrate methods of teaching in the out-of-doors. The class was handled as if it were a typical high school class in biology. Various organisms and habitats were discussed as they were encountered. The trip was followed by detailed observation of the winter characteristics of fifteen species of trees. Notes were taken to be used in the making of a tree key.

Tuesday afternoon: Practice in construction of a key to the local trees followed by free time for students to prepare for following day.

Tuesday evening: Discussion of school camping programs for high school biology and conservation classes.

Wednesday morning: Each student in turn acted as leader and conducted a lesson in the out-of-doors or in-doors using materials gathered in the area. A list of the lessons is given below.

Wednesday afternoon: Continuation of morning activities. Departure for University campus.

Outdoor Lessons

Topics chosen by the students and presented by them included:

Identification and life cycle of the mosses
Identification and growth of lichens
Fungi found in the winter

A clump of little bluestem grass in a prairie opening is the center of attention

Identification of oak trees
Determining tree age by the use of increment borer
Principles of forest conservation
Commercial uses of local trees
Virginia white tail deer (wild and captive deer available)
Birds of winter
Structure of bird nests
Biology of fish (large carp found on river bank)
Winter life in a decaying log
Demonstration of grafting
Growth habits of various vines
Seeds and fruits found in winter
Insect galls
Study of soil profiles
Soil conservation practices
Organisms of one square meter quadrat of prairie
Influence of man upon the forest area
Nature photography

These individual lessons taught by the students were the most worthwhile aspect of the three days spent in camp. This first-hand experience gave the students some interesting insights into learning in the out-of-doors.

Some students discovered that they were poorly prepared to teach in the out-of-doors because of lack of experience and academic background. They freely discussed their need for more field courses.

Lessons in the presence of living things such as deer, birds, lichens, etc., in their natural environment were especially interesting. Spontaneous lessons on unexpected discoveries

A student points out the growth of a vine on a sapling

were found to be very worthwhile, for probably the most interesting lesson of all came about because of the accidental discovery of a dead fish.

Evaluation

The final assignment for the outdoor experiences was a written evaluation. Highly favorable reactions were received from the students. Some indicated that the learning experience was the high point of their college careers and that it should be included in all future classes. Others stressed the value of the opportunity to learn from first-hand experience in a natural setting. Students and instructor living and working together in an informal camp environment was considered valuable by many. The instructor noted a much-improved *esprit de corps* in the class.

This type of field experience will be continued in the future. It is planned that all future "methods" classes in biology will spend at least three days at the field campus in order to learn by doing.

The activity can be adapted to any season of the year. A second class was taken to the camp in March. For the school year of 1958-59, new classes will have this experience in October and in April.

Laughing Doves in the Lab

W. F. HOLLANDER

Genetics Department, Iowa State College, Ames, Iowa

The "blond" color variety, typical of the domestic ring neck or laughing dove. Female specimen.

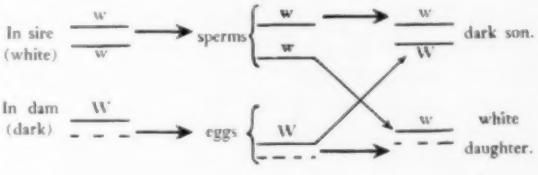
The "white" variety—actually not devoid of pigment.

Students when asked what kind of bird laughs are likely to respond "hyena," or "parrot," or "laughing jackass," or even "Woody Woodpecker." Few are acquainted with the domestic dove, part of whose repertoire is a laugh which very possibly inspired Woody.

This is not the mourning dove, though of similar size. No permit is required to keep it. Strangely, few teachers have recognized its value, though it has been used extensively in research. With its open nest, the life cycle can be followed intimately from early embryo, and the birds will thrive in a small cage for years, with a minimum of care and inconvenience.

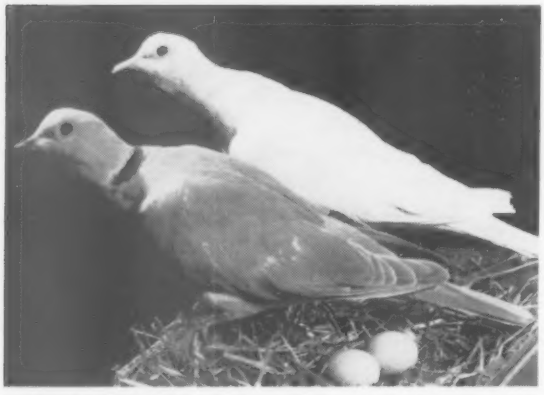
Three color varieties exist: blond (the most common), white, and dark (rare). Cole[3] discovered that these are alternative in inheritance and sex-linked. Perhaps the most amazing trick the teacher can perform is to tell the sex of a dove embryo two or three days old by its color, and prove it when the bird matures. All one must do is mate white males with blond or dark females. When the eggs are "candled" by holding them against a hole in a cardboard before a bright light in a dark room, the embryo is clearly visible through the paper-thin shell. Embryos with black eyes will be males, while embryos with pink eyes will be white females.

To explain this feat, one assumes that the color genes are borne on the sex chromosomes. Studies of the dove's chromosomes[11] indicate that female's cells have a single sex chromosome while in males there is a pair. We can use w to represent the recessive gene for white, and W for the dominant allele, thus:

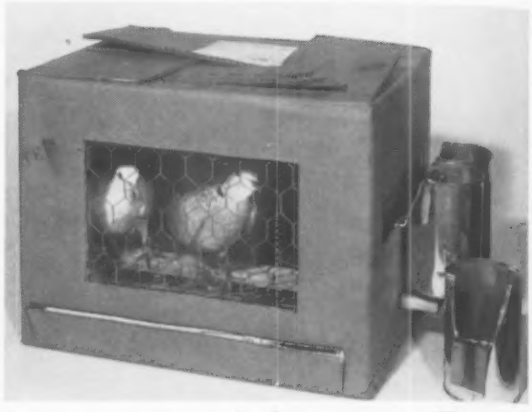


The dash line represents the lack of one chromosome in females.

White doves once were thought to be a separate species, but are merely a color variety. Many pet store operators still do not know it, or try to capitalize on the myth of distinctive origin by calling them "Sacred White Indian doves." The blonds generally go by the names "ringneck dove," "ring dove," "Barbary dove," "collared turtle dove," or "laughing dove." In French they are "tourterelle à collier," and in



"Why is that photographer using such bad language?" The birds were posed in dim light to discourage flying, with the result that they relaxed too easily.



A temporary cage made from a carton. The birds can be kept in such a cage for weeks in excellent health. For adequate exercise and for breeding a cage about two feet in each dimension is desirable. The feed and water cups are made from one-pint tin cans.

German, "die Lachtaube." Doves are generally too cheap for pet stores to get enthusiastic over, but they can be procured with a little urging.

The origin of domestic doves apparently goes back to Bible times, when doves were used as sacrifices. It is now known that the wild species *Streptopelia roseogrisea* of N. E. Africa and the Red Sea region was the progenitor.[14] Nevertheless, there has been some confusion, started by Aldrovandi about 1600 when he called the domestic form *Turtur indicus*. Linné changed the name to *Columba risoria* but still said "habitat in India." The wild Indian species was later named *Streptopelia decaocto*. Resolution of this "taxonomess" is still not complete. Moreover, the wild species of this genus can all be crossed in captivity, giving more or less fertile hybrids, so that species characters may be transferred.[7, 21]

Domestic doves have also been crossed with mourning doves (*Zenaidura macroura*) but the hybrids produced were totally sterile.[17] Crosses of female doves with male domestic pigeons (*Columba livia*) give practically 100% male hybrids, the female hybrids generally failing to hatch.[5] The reverse cross, when successful at all, gives both sexes of hybrids viable. Only the male hybrids of this extreme cross are able to breed at all, producing progeny occasionally when mated with female doves. These ¾-dove progeny in turn have been sterile as a rule.

The habitat of the wild *Streptopelia roseogrisea* has been described thus: "steppe landscape with isolated groups of trees and bush forest in the vicinity of milo-maize fields. The diet consists almost exclusively of milo-maize and grass seeds."[15] Along the coast of the Red Sea they are said to be "extraordinarily plentiful"; they are "found in every garden and at each and every watering-place . . . . the still hot air resounds with their monotonous *took-tookaroo, took-tookaroo*. They cannot be driven from the wells, are completely tame and confiding."[1] Such a state of affairs suggests absence of predators such as cats.

In the laboratory the doves thrive on poultry feed; a pound will feed a breeding pair for a week or more. Mash is not appreciated by the birds however; they prefer whole or cracked grain, or pellets. Wheat and cracked corn are excellent staple foods as a rule. Chicken "scratch feed" is usually good. For optimum nutrition, especially when breeding, the birds also need a little more or better protein, such as in dried peas, and minerals. Well-crushed shells from hard-boiled eggs furnish the needed calcium; coarse sand dampened with brine made from iodized table salt completes the list. If the birds do not have regular sunlight (not filtered by window glass) they also require a little vitamin D, which can be given by moistening the feed occasionally with cod-liver oil. Poultry pellets provide many of the trace requirements, but care should be exercised that such feed is reasonably fresh.

For tranquility, doves are best kept in pairs in cages of inch-mesh poultry netting. Such a cage, two feet or less in each dimension, can be made in half an hour, at a cost of less than half a dollar. No lumber is required, but a large carton cut down to eight inches high, is

good for the bottom. Fit the cage inside the carton. The wire floor of the cage should be held up several inches above the bottom by rods running through the carton walls.

Furniture for the cage is of three sorts:

(1) a perch-rod, about an inch thick;

(2) a nest-box, such as a cigar box, containing about half an inch of sand, with excelsior packed saucer-like on top;

(3) feed and water cups. Neat cups can be made from discarded tin cans (pint-size). With tin snips make two cuts an inch apart, down from the lip half-way. Next with pliers bend the strip out and down to form a hook. Finally bend the sharp edges of the other part of the cup inward. Such cups should hang on the outside of the cage, holes for the birds to reach out being made about three inches above floor level. Half a dozen cups per cage are desirable, to permit separating the different sorts of items, cafeteria-style.

It is possible to arrange enough cups to provide feed and water for a week. This solves vacation problems to some extent. However, the exposed feed is a great attraction to mice, which should be kept trapped.

Doves are able to adapt to extremely cold weather provided there is no wind. Rapid chilling may however be dangerous to health. Doves are susceptible to about the same range of diseases and parasites as are pigeons,[10] but are less robust. Ordinarily if doves act healthy they are free of trouble, and will live and breed for a number of years. In case of illness, hodge-podge medication is not recommended. If the bird does not recover in a couple of weeks with isolation, rest and good food, it is best killed. An exception is infection of the eye, which can become chronic. Rubbing with carbolated Vaseline or aureomycin has been found curative.

The phenomenal growth of baby doves is always fascinating. Two eggs are laid, about 40 hours apart, and then incubation begins. Hatching occurs in two weeks, and the young, helpless fuzzy babies, are fed "pigeon milk" by both parents. This is a curdy secretion from the walls of the crop, induced by the pituitary hormone prolactin, which was first discovered in experiments with doves and pigeons.[16] The baby squabs rapidly grow feathers and when a month old are as big as their parents. By this time the parents may have a new set of eggs, and the presence of the youngsters becomes unwelcome. The young should therefore be moved to their own new cage. They may be stupid in learning where the feed and water are, so that open dishes on the floor of the cage for a few days are helpful.

Dove behavior has been of perennial interest to many investigators,[6, 22] especially in relation to hormone actions.[2, 18] Little comment seems to have been made on one aspect however—panic. The gentle dove confronted with an unfamiliar object, flashing color, or strange noise may suddenly explode into activity, beating against the cage sides in frantic efforts to escape. The commotion is contagious if other doves are present, and pandemonium reigns briefly. Then, amazed at themselves, the birds settle down to reflect, and soon tranquility is restored. Similarly, doves at first do not like being restrained in the hand, but may perch on one's palm happily without restraint.

There is nothing more gentle than a brooding dove. One can take its eggs or squabs out for examination, or handle the bird without any commotion.

Often students will let a dove loose in the room and then in catching it yank out a lot of feathers. This is no serious matter as feathers regrow in a month or less, and repeated plucking may even be of interest for study.

Surplus young should be given to students or disposed of to pet shops. Some pet shops will board the birds over summer. In any case, don't just turn the birds loose out of doors. Freedom for laughing doves is no laughing matter, as they are easy prey for cats. Much better to pickle them for a lesson in anatomy.

Source References

1. Archer, G. F., and E. M. Godman, "Birds of British Somaliland and the Gulf of Aden." London: Gurney and Jackson. 1937.
2. Bennett, M. A., "The social hierarchy in ring doves. II. The effect of treatment with testosterone proprionate." Ecology 21:148-165. 1940.
3. Cole, L. J., "A triple allelomorph in doves and its interspecific transfer." Anatomical Record 47:389. 1930.
4. Cole, L. J., "A study of hybrid doves." Aviculture (series 2) 2:27-30. 1930.
5. Cole, L. J., and W. F. Hollander, "Hybrids of pigeon by ring dove." American Naturalist 84:275-308. 1950.
6. Goodwin, D., "Observations on the voice and some displays of certain pigeons." Avicultural Mag. 62:17-70. 1956.
7. Irwin, M. R., "Evolutionary patterns of antigenic substances of the blood corpuscles in Colum-

bidae." Evolution 7:31-50. 1953.
8. Lahr, E. L., and O. Riddle, "The action of steroid hormones on the mature dove testis." Endocrinology 35:261-266. 1944.
9. Lehrman, D. S., and P. Brody, "Oviduct response to estrogen and progesterone in the ring dove (*Streptopelia risoria*)." Proceedings, Society for Exper. Biol. and Medicine 95:373-375. 1957.
10. Levi, W. M., "The Pigeon." Second ed., 667 pp., illus. Levi Publ. Co., Sumter, S. C. 1957.
11. Makino, S., T. Udagawa, and Y. Yamashina, "Karyotype studies in birds. II. A comparative study of chromosomes in the Columbidae." Caryologia 8:275-293. 1956.
12. Miller, W. J., "Silky plumage in the ring neck dove." Jour. of Heredity 47:37-40. 1956.
13. Miller, W. J., "The hybrid substance of the erythrocytes of the hybrids between *Columba livia* and *Streptopelia risoria*." Genetics 41:700-714. 1956.
14. Newman, T. H., "The rosy grey turtle dove and others." Avicultural Mag. (series 3) 12:100-104. 1921.
15. Reichenow, A., "Die Vögel Afrikas." vol. 1, p. 413. Neudamm: J. Neumann. 1900.
16. Riddle, O., "Endocrines and constitution in doves and pigeons." Carnegie Inst. of Wash., publ. 572. 1947.
17. Riddle, O., and M. W. Johnson, "An undescribed type of partial sex-reversal in dove hybrids from a sub-family cross." Anatomical Record 75:509-527. 1939.
18. Riddle, O., and E. L. Lahr, "On broodiness of ring doves following implants of certain steroid hormones." Endocrinology 35:255-260. 1944.
19. Staples-Browne, R., "On the crossing of some species of Columbidae and the inheritance of certain characters in their hybrid offspring." Journal of Genetics 13:153-166. 1923.
20. Taibel, A., "Ibridi artificiali interspecifici nel genere *Streptopelia* Bp." Atti, Societa Italiana di Scienze Naturali 88:171-190. 1949.
21. Tange, M., "Further data on the crossing of albino ring doves with white ones." Jour. Faculty of Agric., Kyushu University (Japan) 9:127-142. 1949.
22. Whitman, C. O., Posthumous works.
vol. 1. "Orthogenetic evolution in pigeons," edited by O. Riddle.
vol. 2. "Inheritance, fertility and the dominance of sex and color in hybrids of wild species of pigeons," edited by O. Riddle.
vol. 3. "The behavior of pigeons," edited by H. A. Carr. Carnegie Inst. of Wash. publ. 257. 1919.

BOOKS FOR BIOLOGISTS

THRESHOLDS OF EXISTENCE, Upton C. Ewing, 286 pp, $3.75, Philosophical Library, New York, New York, 1956.

Evolution is here set forth as manifesting in the repetition of criteria a principle through which creation is realized: a principle which approaches the long sought after postulate through which both science and religion may find a harmony in definition. The author portrays the creation of life as the verification of freedom itself, dignifying man as a self-reliant creature whose only restraints are the basic ethics of the will to live.

Fishing—for Nematodes

MARY EILEEN COSTA
Ithaca, New York

"This is like fishing for trout with an anchor," exclaimed a new assistant in Cornell University's nematode research laboratory. The assistant was actually "fishing," but her "fish" were smaller than most—in fact, they were microscopic. It involved removing individual nematodes from the liquid medium, using a bamboo splinter.

Nematodes are round worms, but set off in a class all by themselves. They are closely related to a number of the invertebrate animals, an example being the rotifers. The parasitic nematodes are often called eelworms because they resemble in general form and shape an eel, and they have undulating movements in the water. How many different kinds of nemas are there? Many! Besides the free-living or saprophytic nemas, there are nemas parasitic to plants, animals and insects. In other words, nematodes exsist in or on almost every form of life and in almost every place. The nematodes vary in size from one-sixty-fourth of an inch in length to some which are over a yard long.

Elephantiasis, a disease of humans, is caused by a nematode which is not common in this part of the world. Even though free-living nemas are as easy to find, parasitic ones should be used to demonstrate in the classroom because of their economic importance. One of the better known plant parasites is the Golden Nematode. So named because of the color of the swollen female, it is a major potential threat to the potato industry of the United States. To date this nematode has been confined to Long Island because of rigid quarantine laws, which even prohibit the shipment of live specimens for research purposes. Only people living on Long Island would be likely to find the Golden Nematode in their soil.

Fortunately for the biology teacher, one of the most common genera, *Pratylenchus*, is also one of the easiest to find and identify. A good place to find *Pratylenchus* is in the

A drawing of *Pratylenchus* taken from a microphotograph showing the proportions of the genus. A.—The stylet. This is the proportion and position when it is withdrawn into the nematode. B.—The esophogus extending back over the anterior end of the intestine giving the diagonal dark area seen under the microscope. C.—Attention to the blunted or rounded tail, one of the diagnostic characteristics. D.—The vulva or female sex organs. It occupies a position of one-third or less of the body length from the tail.

roots, especially the roots of fruit trees and orchard grass. How do you capture nemas? Follow these simple steps and you should get some magnificient specimens.

Collect a small handful of fruit tree rootlets, being sure to get as many of the smaller root hairs as possible. The roots of an old apple tree make a good hunting ground. Wash them carefully to get off most of the soil, and place in a covered jar for two or three days to give the nemas time to migrate to the outside surface of the root. Should the roots tend to dry during this time, add two or three milliliters of water to the jar. After sufficient time has elapsed, pour about ten milliliters of tapwater gently over the roots while they are still in the jar. Then pour the liquid from the jar into a Syracuse watch glass. It should contain live nematodes. Using the 30 or 40 power objective of a compound microscope, you'll see many small wriggling worms. These worms are your nematodes!

Now to identify the common genus *Pratylenchus*. You may find segmented worms as well as unsegmented nematodes. Many of the nematodes have annules but these are not segments. *Pratylenchus* will be among the smaller ones in the water. Because we used only the nemas found on the roots, we can make our first general classification separation—parasitic or free-living. All parasitic species have a spear or stylet. Thus if there is a stylet present, the nematode is probably parasitic. This stylet is extended when used by the organism for piercing the plant tissues but is usually seen withdrawn into the "head."

Each genus is identified by a combination of characteristics. The characters which separate *Pratylenchus* are quite distinct. The stylet is clearly seen as a definite black line, which is about as long as the width of the lip region or "head" end of the animal. The upper third of the body should appear nearly transparent; this is true of most parasitic forms under the proper conditions. Next, look at both ends of the worm. If they are blunted or rounded, you are definitely on the right track. Now check the position of the vulva or female organs. If the vulva is located about one-third of the body length away from the tail, you are close. Here's the clincher. If your specimen has a diagonal dark area, it is probably a *Pratylenchus*. (see illustration)

This dark diagonal area is caused by an overlapping of the esophagus and the anterior part of the intestine. Of the group of nematodes having this general form, this marking occurs only in *Pratylenchus*.

If you wish to separate individuals, or to make permanent slides of nematodes, you'll have to go "fishing." This involves playing the wriggling nematode to the surface of the water and quickly lifting it either to another dish or a microscope slide. The fishing tackle consists of a very slender bamboo splinter. As your skill as a fisherman improves, you will find this a rather different and enjoyable way to go "fishing." As one fisherman to another, good luck! You have an advantage on your side—the pond is stocked!

Books for Biologists

THE CHRONICALLY ILL, Jerome Fox, 229 pp, $3.95, Philosophical Library, New York, New York, 1957.

This book is the direct result of a two decade study and analysis of the long-term patient and the aged. This is a sociological approach to the problem, and offers a guide and encouragement to the rehabilitation programs.

(Continued on page 27)

An Inductive Approach to the Teaching of Science Through Teacher-Pupil Planning

HERBERT F. A. SMITH
Southern Illinois University, Carbondale, Illinois

The boy standing before the biology class was not well dressed. In a school where most pupils were better dressed than he, his blue work shirt and jeans seemed out of place. More important than his apparel was the long birth mark than ran from his hairline down to his cheek like a large exclamation mark. Such a disfigurement might easily explain why a boy would be too shy to stand before a class and speak. But this boy was not shy. With great self-assurance he was describing to the class the results of some work he had been doing in the laboratory. This was my introduction to the teaching being done by one of the most interesting science teachers I have met.

Later other facts came to light about the pupil with the birthmark. His teacher told me that the boy and his family had moved from the midwestern state to the Pacific coast. After two months in the high school of the city to which his family had moved, this boy had hitchhiked back to the midwest and was supporting himself by service station employment so that he might be able to attend school there.

As time went on, I found other opportunities to visit this teacher and his classes in chemistry and biology. One morning he showed me a report done by a boy who had an I.Q. of seventy, according to the school records. This boy had not been relegated to a back seat where he could do a minimum of damage to the rest of the class. He had taken upon himself the responsibility for a task within his limitations and had done well. His report was complete, well-organized, grammatically correct, and neatly presented. When I asked about the probable future of such a person in chemistry, the teacher felt that he could well pull his weight as a routine worker in the laboratory in one of the local mills or canning plants.

These two boys are only examples of the highly motivated youngsters present in the classes. Each of the other pupils was apparently imbued with the same enthusiasm. During laboratory periods they all went right to their work; during classroom periods all participated in discussion; during research periods all went about their tasks without any urging from the teacher.

Of course the teacher had a very enviable local reputation and was a very personable young man but these facts were not sufficient to explain the excellent learning situation which had been developed. Fortunately he was more than willing to describe his concept of teaching and his approach to me.

First of all, the teacher pointed out, one must understand the principles of learning before he can teach effectively. Beyond the ordinary course in educational psychology, this young man had taken graduate work in this field at the state university. Added to this, he had read and analyzed many of the current textbooks in this field. With the knowledge so gained, he had devised a chart of learning process as it applies most particularly to his field. He had the needs of the pupils identified, the experience available to meet these needs listed, and the objectives of science teaching outlined in their relationships to the needs and experiences. The principles on which he was operating are the ones familiar to all of us: learning depends largely on motivation and motivation in turn is a power within the learner; it is not effectively imposed.

The second point comes from the first. If the needs of the pupils are the basis for instruction, these needs have to be recognized by the pupil and expressed. The technique essential to the support of this principle is teacher-pupil planning— a concept to which much lip service has been paid but which has not been wholeheartedly accepted by many teachers and administrators. I happened to be in a chemistry class which was the planning time for a study of solutions. The class had spent some time the day before in groups of

four or five discussing the value of such a study, its purposes and the most promising approach to these purposes. During the class period, the chairman presided and the teacher sat with me at a table in the class. Each group leader told the class what his group thought about this study and a recorder wrote the pertinent facts on the board. At the close of the period, the results of the groups' efforts were synthesized into a plan involving laboratory work, reading research, class discussion, and reporting.

The division of the class into groups had been done arbitrarily at first but the teacher had sociograms and personality studies involving each pupil. He had a rotation system worked out so that each person had opportunity for leadership and also an opportunity for him to evaluate himself, with the aid of the others in his group, as a leader. I consider this plan the key stone to the whole approach. With the encouragement and guidance of the group, and the confidence that resulted from it, each boy and girl felt able to go ahead on his own resources.

As a result of the planning session, it was concluded that part of the knowledge essential to the study of solutions was some theoretical background that the teacher could supply. Accordingly he was asked to teach a lesson on a certain day and to cover certain points in the study; I suppose few of us have had our lesson plans outlined for us by the class we plan to teach, but this man did! It is hardly necessary to say that he accepted the assignment graciously.

Most of the work, both in the laboratory and in the library, is based on a truly inductive procedure. Once a pupil has accepted a responsibility for laboratory work, the task is his to be done by him with guidance from the teacher when needed. He has his problem clearly in mind; he forms his hypotheses, does the experimentation he feels is needed, considers his evidence and makes his own conclusions. These conclusions are submitted to the class during a discussion period and are either accepted or rejected by the group. If accepted, a conclusion contributes to a generalization stated by the group. The case of a tenth grade girl may illustrate this procedure. The class was studying vertebrates and, of course, the subject of birds was brought into the preliminary discussion. One girl offered to mount a bird skeleton as her contribution. From somewhere she obtained a bird—it may be she found it on the highway—cleaned the skeleton, and mounted it. She presented a report of this work and the conclusions she had reached from it, along with the skeleton, as her part of the study. Other pupils, of course, had worked on other projects.

It is plain to the reader, but should be emphasized, that this type of teaching takes care of many of the problems arising from the great span of intelligence and the various abilities met in the typical high school class. In the first place, the teacher is careful that no pupil is rushed into any position of leadership beyond his depth. Those who do not know how to lead are helped by observing others. No uniform assignments are made with deadlines to be met—each pupil determines what he can contribute and then is obligated to do so. Reading and laboratory work is pursued by the boys and girls; it is not imposed on them. The classroom library has books from the junior high level to the college level. Many pupils of normal intelligence find it quite beneficial to do research in the college level texts. The more intelligent find the high school texts, in some cases, too shallow for their purposes.

The teacher claimed only that he likes teaching in this manner and that the pupils progress well according to standardized tests. He would not go beyond this. Further questioning, though, showed that an unusually large percentage of his pupils go on to college to enter the fields of science, medicine, and teaching. From an observer's point of view, he has developed very practical answers to some of our pressing problems of science teaching.

NABT Member Writes Manual

MANUAL OF SOUTHERN FORESTRY, Howard E. Weaver and David A. Anderson, 368 pp, $3.20, The Interstate Printers and Publishers, Inc., Danville, Illinois, 1954.

This manual, written primarily for forestry instruction in vocational agriculture in the South, contains much information of interest to biology teachers—such chapters as "Free Study," "Artificial Reforestation," "The Forest Environment," "Wood Identification and Uses," and "Wood Preservation".

Teaching Environmental Responses

JOHN FORSYTHE, JR.
Biology Department, College of San Mate

Introduction

Tangible experimental evidence of the influences of environmental conditions is often quite difficult to demonstrate with the commonly used high school biology equipment. The effects of the environment are often without meaning to the average high school student. Terms such as *epiphyte*, *rain forest*, or *succulent* are often used but fail to convey the dynamic nature of the conditions surrounding us. To illustrate and to make concrete to the student the factors which influence living things seem, to the author, to be most desirable, indeed, most necessary. To properly understand natural phenomena in the world of life around us requires a functional working knowledge of broad and basic life concepts. To this end the following simple and relatively inexpensive demonstrations or student experiments are offered.

Procedure

The basic effects of light upon the photosynthetic process is one of the "standard" high school biology experiments. The bleaching of the leaf in alcohol and the subsequent darkening with iodine effectively show starch formation. While starch formation in the leaf shows the result of photosynthesis, this result is only a partial effect of light. Light plays a far more active role than that usually included in a beginning biology course. Other light-controlled factors should be included in a basic biology. One of the easiest factors to show is the effect of varying periods of illumination upon a plant. *Coleus* seems to be one of the best plants to use for this purpose since it grows rapidly, roots easily from cuttings, produces optimum growth under easily attainable temperatures, and has multicolored leaves. The coloration of the leaves is a function of the length of day.

The planting medium chosen was the U. C. Soil Mix "C".[1] This is a combination of fine sand and peat moss in a ratio of 50%-50% by volume. This medium is easily mixed from readily obtainable ingredients, possesses good physical characteristics, and is low in nutrients. Sterilization by steaming or other methods does not affect its properties. Some type of balanced fertilizer preferably containing the micronutrients should be added for optimum growth.

Coleus seeds are started in the medium in conveniently sized flats or other type containers and later transferred to plant bands or small pots. In order to control the length of photoperiod (day length) some form of timer is necessary. This item is the only one of significant cost and is one not usually found in a high school. The timer selected (G.E. 699X1) is designed for controlling showcase or store window fixtures. Lights may be turned off and on at any predetermined time in order to vary the illumination period. Fluorescent fixtures offer the most economical source of illumination as well as overcoming the excess heat factor. At a distance of 6-8 inches, 250-400 foot-candles may be obtained from a double-tube 15-watt unit. The young *Coleus* plants should develop two or three sets of true leaves before being used experimentally. One plant of each group should be used for a control. Photoperiods may be varied from that of normal daylight (8-12 hours) up to continuous light. Good results may be obtained by setting the timer for a 16-hour day. The author's method is to allow the plants to be exposed to normal daylight and to supplement with artificial fluorescent light for a total of 16 hours. Striking effects may be obtained by this method since the maximum development of the anthocyanins depends upon the photoperiod. Under the normal winter day (short photoperiod) the anthocyanins tend to develop only along the midrib and to progress only slightly toward the leaf margin during the aging of the leaf. Under increasingly longer photoperiods, the anthocyanins may almost completely blot out the green

[1] Baker, Kenneth F. (Editor). *The U. C. System for Producing Healthy Container-Grown Plants.* University of California College of Agriculture. September, 1957. Page 73.

color of the leaf. Genetic variability in coloration may be eliminated by using cuttings from a single plant.

In addition to the photoperiod response, *Coleus* is easily adaptable to both phototemperature (day temperature) and nycto-temperature (night temperature) experiments. Went[2] has shown that the optimum growth of *Coleus* occurs at a nyctotemperature of 17°C (62°F) and a phototemperature of 23°C (73°F). Procedures varying the temperatures may be obtained by using an aquarium thermostat controlling some type of heating element in a closed container. Often a terrarium placed outside during the daytime will result in very high phototemperatures. Low nyctotemperatures are usually found in the average biology classroom. The inhibitory or detrimental effects of either nycto or phototemperatures are evident in the *Coleus* often in two or three days.

Conclusion

The conclusions that the student derives from the above series of experiments tend to give him a better and more substantial understanding of the role of environment in controlling plant growth. In this way the student may have a better appreciation of biology not only at the conclusion of the experiments but later when he plans and landscapes his own garden. Biological concepts which are made real and useful serve to increase the value of the biology class for the student.

[2]Went, Frits W. *The Experimental Control of Plant Growth*. Chronica Botanica Co. 1957. Page 148.

Artificial Hormone

A new, direct synthesis of aldosterone—the hormone that controls the salt balance of the body—starting with simple coal tar products, was described by Professor William S. Johnson of the University of Wisconsin. Chemical, physical and biological tests have shown that aldosterone is extremely active, having 30 times as much salt-retention potency as the artificial adrenal hormone called DOCA, or desoxycorticosterone acetate. Will aldosterone, now that it is potentially available by synthesis, be useful in the treatment of human ailments such as Addison's Disease? Dr. Johnson pointed out that such possibilities are at the moment purely speculative.

Diabetes

The existence of two distinct types of diabetes in man has been demonstrated for the first time by the response of patients to the new oral drug Orinase, said Dr. Henry Dolger, chief of the Diabetes Clinic of Mt. Sinai Hospital, New York. "Until now diabetes mellitus has been considered one disease entity which could be treated with insulin," Dr. Dolger explained. "Many investigators had felt that actually the condition represented a number of different kinds of diabetes. Orinase, by proving to be effective in over 50 per cent of the adult diabetic population, has thereby created the first separation of diabetes into two categories."

Orinase, which Dr. Dolger considers the major advance in diabetic treatment since the discovery of insulin thirty-seven years ago, has the effect of stimulating the insulin-producing beta cells within the human pancreas to do their job more efficiently. Insulin—a hormone secreted by the healthy pancreas—helps the body convert food to energy. In diabetic patients, the body's mechanism for utilizing sugars and starches to produce energy fails to function properly, and excessive accumulations of body sugars are "spilled" into the blood and urine. Orinase is capable of lowering these excessive sugar levels.

Treatment with Orinase stimulates the production of insulin in a large percentage of adult diabetics—especially those who have developed the disease in middle or old age.

Dr. Dolger, a physician, stated that "the majority of diabetics who may respond to Orinase are suffering from diabetes, not due to an absolute lack of insulin, but rather to some interference with its proper liberation or use." On the other hand, those who do not respond to Orinase, such as the "juvenile" diabetics, who acquire the disease in childhood, have no inherent insulin available."

"This is a most important implication for the future elucidation of the cause of diabetes," he emphasized, "and this definition into two groups will afford a better research material and a clearer understanding of the disease . . . With over 300,000 diabetic patients in this country now using Orinase successfully, future expansion to include three-fourths of all diabetic patients of the 'adult'

type will eventually make the number of users rise to about a million."

He attributed the clinical importance of Orinase to its ability to free the majority of diabetics—some 75 per cent of the nation's 3,000,000,000 are the so-called adult type—from daily injections of insulin. In addition, he noted, Orinase frees diabetics from the danger of coma brought on by lowering blood sugar too rapidly. He cited Orinase also for its value in controlling diabetes in patients allergic to insulin, and for its "frequently remarkable success in obtaining better control of glycosuria (sugar in the urine) and hyperglycemia (excess sugar in the blood) than with insulin.

"Orinase gives promise as a new diagnostic tool in the clinical detection of diabetes," he continued, and also "gives promise in the prophylactic approach to the prevention of diabetes and the possible arrest of the degenerative complications of diabetes which have so far failed to benefit from insulin therapy."

A recent Health Information Foundation report stated that diabetes ranked eighth among the leading causes of death in 1957, and that, although diabetes mortality has declined, the incidence of diabetes has risen. In addition to the 1,000,000 known victims of diabetes, the HIF report predicts that some 4,750,000 people alive today will develop diabetes during their lifetime—usually in middle or old age. Many of these people do have cells which can be stimulated by Orinase to produce insulin.

USEFUL OPTICAL BARGAINS!

EDMUND SCIENTIFIC CO. is cooperating in the Science Teaching Program in High Schools and Colleges throughout America, by developing scientific teaching aids at low prices. Send for Bulletin 50-AX.

Just the Thing for Examining Insects, Butterflies

Fine, American-Made Instrument at Over 50% Saving

STEREO MICROSCOPE

Up to 3" Working Distance — Erect Image — Wide 3 Dimensional Field

Now, ready after years in development—this instrument answers the long standing need for a sturdy, efficient STEREO MICROSCOPE at low cost. Used for inspections, examinations, counting, checking, assembling, dissecting. 2 sets of objectives on rotating turret. Standard pair of wide field 10 X Kellner Eyepieces give you 23 power and 40 power. Additional eyepieces available for greater or lesser magnification. A low reflection coated prism erecting system gives you an erect image—correct as to right and left—clear and sharp. Helical rack and pinion focusing. Interpupillary distance adjustable. Precision, American-made! 10-DAY TRIAL . . . complete satisfaction or your money back.

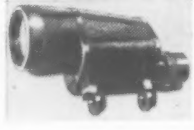
Order Stock No. 85,056-AX.....$99.50 f.o.b. (Shipping wt. approx. 11 lbs.) Barrington, N. J.

Low Power Supplementary Lens Attachment for above Stereo—provides 15 X down to 6 X with clear, extra large 1½" field at 6 X.

Stock No. 30,276-AX.....$7.50

Just Right for Bird Watching

7 x 50 MONOCULAR



This is fine quality, American-made instrument—war surplus! Actually ½ of U.S. Govt. 7 x 50 Binocular. Used for general observation both day and night, for Bird Watching and to take fascinating telephoto shots. Brand new, $35 value. Due to Japanese competition we close these out at a bargain price. Directions and mounting hints included.

Stock No. 50,003-AX.....$15.00 Postpaid

See the Stars, Moon, Planets Close Up!

3" Astronomical REFLECTING TELESCOPE

60 to 160 Power - An Unusual Buy!

Famous Mt. Palomar Type

PHOTOGRAPHERS!

Adapt your camera to this Scope for excellent Telephoto shots and fascinating photos of moon!

Assembled - Ready to Use! You'll see the Rings of Saturn, the fascinating planet Mars, huge craters on the Moon, Star Clusters, Moons of Jupiter in detail, Galaxies!

Equatorial mount with lock on both sizes. Aluminized and overcoated 3" diameter high-speed f.10 mirror. Telescope comes equipped with a 60 X eyepiece and a mounted Barlow Lens, giving you 60 to 160 power. An Optical Finder Telescope, always so essential, is also included. Sturdy, hardwood, portable tripod.

Free with scope: Valuable STAR CHART and 272 page "Astronomy Book."

Stock No. 85,050-AX.....$29.95 Postpaid

ERECT IMAGE LOW POWER MICROSCOPE

5X, 10X, 20X

$80.00 Value — Only $19.95

Extremely sturdy with rack and pinion focusing, color corrected optics, turnable microscope body for inclined viewing, three different powers, long working distance under objectives, sufficient eye relief for easy viewing. Made from war surplus optical instrument so that you actually get $80.00 of value. Weighs 4 lbs., 13" high. 10-DAY FREE TRIAL! Accessory objectives available for powers of 15X, 30X, 40X.

Stock No. 70,172-AX.....$19.95 Postpaid

GET OUR BIG FREE CATALOG No. AX

We have the world's largest variety of Optical items. Bargains galore . . . War Surplus — Imported — Domestic! Our stock includes Microscopes, Telescopes, Satellite Scopes, and Spectroscopes, Prisms, Lenses, Recticles, Mirrors and dozens of other hard-to-get Optical items.

Ask for FREE CATALOG No. AX

ORDER BY STOCK NUMBER . SEND CHECK OR MONEY ORDER . SATISFACTION GUARANTEED!

EDMUND SCIENTIFIC CO., BARRINGTON, N. J.

Bio - Buy - Lines

BIOLOGICAL SPECIMENS—Alive or preserved. Reptiles a specialty. Ray Singleton, Interbay Station, Tampa, Fla.

ANATOMICAL MICROSCOPE SLIDES

Expertly prepared human histology microscope slides. Ten years of experience guarantees unsurpassed workmanship. Student and instructor sets available at low prices. Quantity discounts. Special work prepared to order. Write for our free list of slides and pamphlet on tissue technique.

BAY HISTOLOGY SERVICE
409 Roosevelt Way, San Francisco 14, California

CONNECTICUT VALLEY BIOLOGICAL SUPPLY CO.
QUALITY MATERIALS—LIVING & PRESERVED
89 Kent Road — Springfield 9, Mass.

PHASE FILMS

The Phase Films are mature single-purpose films presenting the most significant microbiological phenomena disclosed in living organisms by the Nobel winning Phase-Contrast method.

Photography of living organisms NOT ANIMATION.

Write for titles, descriptive folders or previews.

ARTHUR T. BRICE
Phase Films — Sonoma, California

BOOKS FOR BIOLOGISTS

GENERAL AND APPLIED ENTOMOLOGY, V. A. Little, 543 pp, $7.00, Harper and Brothers, New York, New York, 1957.

Written simply and clearly, this text treats the science of entomology as a whole with a balanced consideration of taxonomy, morphology, physiology, biology and control. There are simple identification keys for laboratory work, and adequate material on insecticides, control, collecting, mounting, and preserving.

COMMUNICATION, ORGANIZATION AND SCIENCE, Jerome Rothstein, 110 pp, $3.50, The Falcon's Wing Press, Indian Hills, Colorado, 1958.

The author shows that measurement and communication have the same underlying logical structure, and investigates the consequences of their close relationship to modern conceptions of entropy and organization. It is pointed out that science and religion are intimately connected, both by common subject matter and advanced logical considerations.

To Serve

The Busy Biologist
The Cooperative Advertiser

Recognizing the pressure of your duties and knowing your interests in the products our advertisers have to offer in the field of biology, you need only put checks on the squares below, sign the coupon and mail it to Muriel Beuschlein, Managing Editor, 6431 S. Richmond St., Chicago 29, Illinois.

January 1958

☐ American Optical	*information*
☐ Bausch and Lomb	*Folder D 1074*
☐ Biological Research	*catalog*
☐ Carolina Biological	*catalog*
☐ Clay-Adams	*literature*
☐ Denoyer-Geppert	*circular #57B*
☐ Difco Laboratories	*literature*
☐ Edmund Scientific	*catalog AX*
☐ General Biological	*catalog #60*
☐ General Biological	*Turtox News*
☐ Ginn and Co.	*literature*
☐ Graf-Apsco	*catalog*
☐ D. C. Heath	*literature*
☐ Harvard Apparatus	*literature*
☐ National Film Board	*catalog*
☐ A. J. Nystrom	*catalog*
☐ Testa Mfg. Co.	*literature*
☐ Triarch Products	*catalog*
☐ Unitron Microscopes	*catalog*
☐ United Scientific	*catalog*
☐ Visual Sciences	*literature*
☐ Ward's Natural Science	*catalog*
☐ Welch Scientific	*circular*

Is your regular supplier listed above?
If not, send us the name and address.

(Please Print)

Name_____

Position_____

School Name and Address_____

_____

City_____ State_____

UNITRON student microscopes offer

UNITRON STUDENT AUTO-ILLUMINATION MICROSCOPE, MSA

The UNITRON Student Auto-Illumination Microscope, Model MSA, employs a newly designed stand in which all components and controls are within easy reach. The inclined eyepiece tube allows comfortable posture and may be turned in any optional observing direction to permit two students sitting side by side to share a single instrument. With the built-in illuminating system of the superior low-voltage type, each student is assured of the correct lighting. The transformer is conveniently housed in the microscope base itself where it contributes to the stability of the stand rather than to the clutter of the laboratory table.

Model MSA comes complete with triple revolving nosepiece and three objectives: 4X, 10X, 40X; three eyepieces: 5X, 10X, 15X; coarse focusing with safety stop; fine focusing; condenser and iris diaphragm; filter holder and filter; accessory substage mirror; wooden cabinet and dustcover. Mechanical stage available at extra cost.

In quantities of 25 or more—$94.16 **only $107**

UNITRON STUDENT MICROSCOPE, MUS

Despite its low cost, UNITRON Model MUS offers features lacking even in much more costly models usually offered for student use. For example, both fine and coarse focusing are provided — not merely a single focusing control; an iris diaphragm to regulate aperture for highest resolution — not merely a disk diaphragm; and a condenser system for optimum illumination.

The optical performance of Model MUS at each of its magnifications is equivalent to that of expensive research models. All mechanical parts are machined to close tolerances and the stand is beautifully finished in black and chrome. Model MUS comes complete with triple revolving nosepiece and three objectives: 5X, 10X, 40X; choice of two eyepieces from: 5X, 10X, 15X; coarse focusing (accessory safety stop available); condenser with iris diaphragm; inclinable stand; planoconcave mirror; wooden cabinet and dustcover. Mechanical stage available at extra cost.

In quantities of 25 or more—$66.60 **only $74**